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Preoperative predictors of adherence to dietary and physical activity recommendations and weight loss one year after surgery

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Abstract

Background

Weight loss and weight loss maintenance vary considerably between patients after bariatric surgery. Postoperative weight gain has partially been explained by lack of adherence to postoperative dietary and physical activity recommendations. However, little is known about factors related to postoperative adherence. The aim of this study was to examine psychological, behavioral and demographic predictors of adherence to behavior recommendations and weight loss one year after bariatric surgery.

Methods

In a prospective cohort study, 230 patients who underwent Roux-en-Y gastric bypass (RYGB) were recruited from Oslo University hospital from 2011 to 2013. They completed a comprehensive questionnaire before and one year after surgery. Weight was measured preoperatively, on the day of surgery and one-year postoperatively.

Results

Mean BMI was 44.9 kg/m^2 (SD = 6.0) preoperatively and 30.6 kg/m^2 (SD = 5.2) one year after surgery. Patients lost on average 29.2 % (SD = 8.2) of their initial weight. Predictors of dietary adherence were years with dieting experience, readiness to limit food intake and night eating tendency. Preoperative physical activity and planning predicted postoperative physical activity whereas predictors of weight loss were higher frequency of snacking preoperatively, greater past weight loss, and lower age.

Conclusion

Several preoperative psychological predictors were related to postoperative adherence to dietary and physical activity recommendations, but not associated with weight loss. Interventions targeting psychological factors facilitating behavior change during the initial postoperative phase are recommended as this might improve long-term outcomes.

Introduction

Expected weight loss after Roux-en-Y gastric bypass (RYGB) is 25–35% of initial body weight [1, 2], but weight loss and weight loss maintenance vary considerably between patients [1]. This variability is partially due to differences in adherence to dietary and physical activity recommendations, as the physiological changes obtained through surgery alone do not necessarily result in a positive long-term outcome [3]. Understanding post-surgical adherence behavior could help to optimize outcomes. The identification of pre-surgical predictors of adherence might point to viable targets for psychosocial interventions preparing patients for the requested lifestyle change after surgery [3]. Although initial postoperative weight loss is estimated to reflect the physiological effects from the surgery to a larger degree than psychological and behavioral factors [4], this period might be critical for initiating behavior change necessary for weight loss maintenance. Thus, studies examining the impact of preoperative psychological predictors of postoperative behavior as well as weight loss are needed [5].

The majority of patients reach maximum weight loss 1–2 years after surgery [1], but thereafter, some patients experience weight gain [2]. Except for physiological mechanisms, the most common reasons for postoperative weight gain are sedentary lifestyle and increased consumption of high-caloric food [6]. Qualitative studies have shown that patients tend to overestimate the effect surgery will have on weight loss, despite being provided with information about the value of making and sustaining dietary and physical activity changes postoperatively [7]. Many perceive surgery as an external measure to limit overeating, which does not primarily require effort for personal behavior

change [8]. This implies that it is of great importance to identify individuals who are having difficulties changing their behavior in the initial period after surgery in order to intervene at an early stage [3].

Adherence to dietary and physical activity guidelines is associated with greater weight loss after surgery [9], but little is known about factors facilitating adherence [10]. Cognitive restraint and self-efficacy has been identified as predictors of dietary adherence [10, 11]. Self-efficacy has also been related to patients' intention to adhere to post-surgical recommendations [12] and, in particular, intention to be physically active predicts adherence [13]. Anxiety and depression have been associated with poorer dietary adherence [10, 14]. While preoperative physical activity is related to postoperative activity [15], evidence on the relationship between preoperative eating behaviors and postoperative adherence is inconsistent [16].

To extend our understanding of what facilitates bariatric surgery patients' adherence to behavior recommendations postoperatively, we conducted the current study based on data from the ongoing prospective Oslo Bariatric Surgery Study (OBSS). The main objective of OBSS is to identify psychosocial predictors for long-term weight maintenance by studying various factors involved in the self-regulation process, which refers to the ability to change one's behavior in line one's goals [17]. The different variables (expectations, readiness to change behavior, planning, self-efficacy, self-esteem, body image, depression/anxiety, previous behavior, etc.) relevant for the self-regulation process can either facilitate patients' behavior change postoperatively or function as a barrier.

The aim was to examine psychological, behavioral and demographic factors as predictors of adherence to behavior recommendations and weight loss one year after bariatric surgery.

Methods

Participants and procedures

The patients were recruited at the Centre for Morbid Obesity and Bariatric Surgery at Oslo University Hospital, Norway, from February 2011 to September 2013. Patients aged 18–60 years old with body mass index (BMI) $\geq$ 40 kg/m^2 or $\geq$ 35 kg/m^2 and obesity-related comorbidities who had failed at previous weight loss attempts were eligible for surgery. Patient flow is described in Figure 1.

Nearly all the participants (95.7%) attended the clinical one-year follow-up consultation. The majority were women (78.3%), around one third (31.1%) had completed at least a 4-year college/university degree, the employment rate was 72.3% and 58.9% was single. More than half (62.6%) had a BMI of 40-50 kg/m^2 whereas 20% had a BMI > 50 kg/m^2 preoperatively.

Postoperative recommendations

The general postoperative behavioral recommendations are based on the Norwegian National guidelines for healthy diet and physical activity (PA) [18]. Patients are recommended to use whole grain products, eat five portions fruits and vegetables every day, choose meat and dairy products with less fat and eat every three to four hours.

PA of moderate intensity for minimum 150 min/week, or vigorous PA 75 min/week is recommended.

Measures

Weight was measured preoperatively on the operation day (T1) and at the follow-up consultation one year after surgery (T2) using a calibrated Seca 635, III (0–300 kg) platform scale with patients wearing light clothing and no shoes.

Outcome measures

Adherence to dietary recommendations was measured according to the dietary guidelines of the Norwegian Health Directorate [18], which the patients are recommended to follow in addition to the more specific nutritional management postoperatively (e.g., at least 60 g of protein daily, vitamin and mineral supplementation etc.). Only the general dietary recommendations were included in the questionnaire. They were asked: "You have received recommendations regarding how/what to eat after surgery. To what degree does it correspond with how/what you have eaten the last four weeks?" (1 = little, 7 = a lot), followed by six specific recommendations (e.g., 'I eat five portions of fruit and vegetables every day', 'I limit my intake of sugar and fat' etc.) [18]. Dietary adherence was calculated as the composite score averaging across recommended dietary behaviors, with a higher score indicating a higher degree of adherence.

Physical activity was used as both dependent and independent variable and was measured by the International Physical Activity Questionnaire (IPAQ) short-form [19]. Mean scores are calculated by weighting type of activity (walking, moderate and

vigorous) by energy requirements reported as metabolic equivalent values per week (MET-min/week). Walking is defined as 3.3 METS and moderate intensity is commonly defined as 3-5.9 METS [20]. To capture all activity of moderate intensity a continuous measure of total MET-min/week was used to report PA-level in the current study. Change in PA was calculated, but change in dietary adherence could not be calculated because it was not measured preoperatively. The final outcome measure was percent total weight loss, %TWL = [(Initial Weight) – (Postop Weight)] / (Initial Weight) x 100 [21]. Descriptions of the baseline measures are provided in Table 1.

Ethical considerations

Oral and written information about the study was given to all the participants before they gave their written consent to participate. The study was approved by the Data Protection Supervisor, the Regional Committee for Medical and Health Research Ethics (2012/17028), South-Eastern Norway, and the Privacy Ombudsman for Research at Oslo University Hospital.

Statistical analysis

Independent samples t-tests were conducted to compare differences in outcome measures—adherence to dietary recommendations, physical activity, and weight loss—by the different categorical demographic variables (sex, education, employment, and marital status/cohabiting) and by BMI classification ($p < .01$). Pearson correlation coefficients were calculated to determine the relationship between relevant study variables and the three outcome measures ($p < .05$). To examine possible predictors of the different

outcome measures, multiple regression analyses were conducted, and variables that were significantly correlated ($p < .01$) with each of the three dependent variables were included in the regression models. Tests to examine if the data met the assumption of collinearity indicated that multicollinearity was not a concern for any of the predictors (Tolerance > .10, VIF < 10).

Results

Preoperatively, mean BMI was 44.9 kg/m^2 (SD = 5.7), and at follow-up it was 30.6 kg/m^2 (SD = 5.2). The average weight loss (%TWL) one year after surgery was 29.2% (SD = 8.2) (%EWL=73.1, SD =24.0). There were no differences depending on demographic groups (sex, marital status, education and employment) or initial BMI groups (< 40, 40-50, > 50 kg/m^2) for the three outcome variables. Rates of adherence to the dietary recommendations are shown in Figure 2. Regarding adherence to the recommended level of PA, 78.0% of the patients reported levels of activity meeting the standard (600 METmin/week).

The relationships between the preoperative variables and the outcome measures are presented in Table 2. Years of dieting experience (%), readiness to limit food intake, planning, self-esteem, body image, and resilience were positively correlated and depressive symptoms and night eating tendency negatively correlated with adhering to dietary recommendations. Postoperative physical activity (PA) was positively related to readiness to increase PA, magnitude of largest past weight loss, planning, self-efficacy, body image, self-esteem, and preoperative PA. It was negatively related to depressive symptoms, age, and alcohol consumption. Number of previous dietary strategies used,

largest amount of previous weight loss, frequency of snacking and preoperative PA level were associated with postoperative weight loss, whereas age, preoperative weight loss (%), and night eating tendency were negatively correlated with weight loss. Furthermore, possible predictors of change in PA levels were examined and results showed that only preoperative PA level was related to change in PA (r = .42, p< .0001). There were no significant associations between change in PA level and weight loss. Correlations between the dependent variables showed a modest association between PA and %TWL (r = .17, p < .05), but there were no significant correlations neither between PA and dietary adherence nor between dietary adherence and %TWL.

The regression analyses conducted to examine the relative independent contribution of the preoperative predictors are presented in Table 3. The baseline variables that emerged as unique predictors of dietary adherence were years with dieting experience, readiness to limit food intake and night eating tendency. These accounted for 16.5% of the variance in dietary adherence. Preoperative PA and planning predicted postoperative PA explaining 22.0% of the variance. Predictors of weight loss were higher frequency of snacking preoperatively, greater past weight loss, and lower age. The total explained variance was 15.5%.

Discussion

In the current study we examined the relationship between preoperative factors and adherence to dietary and physical activity recommendations and weight loss one year after surgery. The main findings were that psychological factors such as self-efficacy, planning, readiness to change behavior, self-esteem, body image, depressive symptoms,

and resilience were all associated with post-surgical dietary adherence or PA, but there were no associations with weight loss. This strengthens the notion that psychological factors are related to patients' lifestyle adjustment, upon which a positive long-term weight loss outcome is dependent [5]. The identification of psychological factors potentially facilitating or inhibiting patient adherence could provide important information regarding how to assist patients' behavior change (self-regulation process) during the first postoperative period.

The regression analyses revealed that dietary adherence was predicted by dieting experience and readiness to change eating behavior preoperatively. This could imply that previous dieting experience and being prepared to limit food intake before surgery might facilitate adjustment to the postoperative diet. Previous research has shown no association between readiness to change behavior and weight loss [35], coinciding with our findings. However, we did find that readiness to change was related to postoperative behavior. Considering that many patients do not perceive the operation as a means to changing their behavior [8], this finding indicates that we need to address the importance of behavior change during the preoperative phase. A tendency to get up and eat at night preoperatively predicted less dietary adherence. Night eating is not considered as a risk factor of poorer weight loss [36], yet our finding might illustrate how adverse eating patterns can interfere with adherence. As night eating tendency was measured with a single item this finding needs replication, ideally with a multi-item scale.

Planning was identified as one of the predictors of PA. The importance of planning to improve behavior change has been demonstrated in several studies [26]. Cognitive functions (planning, inhibition etc.) and preoperative coping skills have been

related to weight loss after bariatric surgery but the link to adherence is unclear [4, 37]. Our findings indicate that focusing on planning strategies for behavior change both pre- and postoperatively could contribute to improved surgical outcomes. We also found that patients with higher preoperative PA levels were more active postoperatively. This coincides with the findings of King and colleagues who argued that PA level before surgery is the best predictor of PA post-surgery [15]. As new behavior is difficult to establish [17] this finding could imply that patients with lower preoperative PA levels have additional need for support postoperatively in order to become more physically active. The finding that some of the measures displaying bivariate relationships to postsurgical behavioral outcomes such as self-efficacy, self-esteem, body image, depressive symptoms and resilience did not emerge as independent predictor in the regression analyses may reflect relationships between explanatory measures and does not imply that these measures are not relevant for understanding post-surgical behavior change.

Finally, weight loss was predicted by lower age, greater magnitude of previous weight loss, and higher frequency of snacking preoperatively. It might seem like a paradox that higher frequency of snacking predicted greater postoperative weight loss, as unhealthy eating habits are usually difficult to change. Plausible explanations of the result may be physiological changes such as dumping syndrome, patients often feeling less hunger, and change in food preferences/taste [38]. As postoperative snacking is a common reason for weight gain [39], it raises the question of whether patients who engage in snacking preoperatively are likely to return to their old eating habits and therefore require extra supervision postoperatively.

Age as a predictor of weight loss has received only a modest amount of attention, but findings indicate that younger patients lose more weight [40], which coincides with our result. The final predictor of weight loss was greater magnitude of previous weight loss, a finding that contradicts Jantz and colleagues' study, which showed no such association [41]. However, in conventional treatment, greater magnitude of past weight loss has been related to higher weight loss up to 18 months after treatment [42]. Previous loss of significant amounts of weight might reflect useful self-regulation skills and may have resulted in higher self-efficacy with regard to abilities to lose weight [42]. Thus, elaborating on patients' weight loss history can provide valuable information regarding patients' capability for behavior change postoperatively.

This study is not without limitations. For instance, it mainly relied on self-report data. Reported adherence was high, and this might be indicative of an over-reporting of adherence, which has been documented in studies comparing self-report and objective measures of PA [43]. The number of items/scales included in the regression analyses involved a risk of making Type 1 Error, but given the patterns of result, most conclusions would be invariant to corrections of the alpha error level. Study strengths include a large sample size, prospective design, objective weight measures and high follow-up rate. The PRESS-statistics (R^2_{PRESS}) used to cross-validate the regression models suggested that the results are likely to be replicable.

In summary, the study findings emphasize the importance of examining preoperative psychosocial factors in relation to postoperative behavior change in addition to weight loss. While several preoperative psychological predictors were related to adherence to postoperative recommendations, they were not associated with weight loss.

Further research is needed to develop interventions targeting psychological factors facilitating behavior change during the initial postoperative phase, as improved adherence could contribute to long-term weight loss maintenance.

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Disclosures

The authors have nothing to disclose.

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Table 1. Description of scales/items included in the questionnaire

Baseline measures	**Questionnaire (scales/items)**	**Description**
Socio-demographic variables	Sex, age, educational background, employment, and marital status	
Preoperative weight loss (%)		Difference in weight measured at the hospital at first visit and on the day of surgery *[(Initial Weight) – (Operation day Weight)] / (Initial Weight) x 100*.
Diet and weight loss history	Survey for Eating Disorders (SED) [22] Weight and Lifestyle Inventory (WALI) [23]	The questions addressed: Binge eating (1 = never, 2 = previously, 3 = now), number of times lost more than 10 kg, magnitude of largest past weight loss, different dietary strategies used (11 strategies listed), number of times participated in organized weight loss programs, and age started dieting.
Dieting experience (% years)		The percentage of number of years dieting relative to age.
Alcohol use	'How often have you consumed one or more than one unit of alcohol in the space of the last year?'	One unit = one glass of beer, wine, or one drink 1 = never consumed alcohol to 9 = daily/almost daily.
Frequency of snacking **Night eating tendency**	Three items pertaining to the frequency of eating sweets, eating caloric food between meals, and consumption of soda drinks. A single item measured a tendency to eat at night: 'How often do you get up in the night and eat?'	A mean sum score of the three questions was calculated. Higher mean scores (range 1–5) indicated higher frequency of snacking (night eating tendency).

Weight loss goal	'Please indicate the weight you would be happy to achieve as the final result of the surgery'	Weight loss goal was calculated as the relative difference in percentage between the weight patients indicated as "happy weight" and weight measured at first hospital visit.
Outcome expectations	Scale developed for Oslo Bariatric Surgery Study (OBSS)	Expectations regarding life three years after the operation were indicated in relation to nine aspects. Factor analysis yielded two subscales: well-being expectancies (e.g., happy about amount of weight lost, general appearance, self-esteem) and social competence expectancies (e.g., improved sex life, becoming more outgoing, personal success).
Readiness to change behavior	Items from the Readiness and Motivation Interview (RMI) [24], based on the trans-theoretical model of change (pre-intenders, intenders, or actors) [25]	Readiness to limit food intake and increase physical activity was indicated on a response scale from 1 = not ready for change to 10 = trying to change.
Planning (eating and physical activity)	Action planning (specifying when, where, and how to act) Coping planning (forming a strategy regarding how to cope with anticipated barriers and difficult situations in order to uphold the plans) [26]	Wording of the questions: 'I already have made plans regarding … e.g., how to change my eating habits or, … e.g., with whom to be physically active'. Mean scores for action and coping planning (range 1–4) were calculated and used in line with standard procedures.
Self-efficacy	General Perceived Self-efficacy Scale (GSE) [27]. *'General self-efficacy is the belief in one's competence to cope with a broad range of stressful or challenging*	GSE is 10-item measure of a person' beliefs in mastering new behaviors or situations (e.g., 'Thanks to my resourcefulness I can handle unforeseen situations'). Higher mean scores indicate higher degree of self-efficacy (Range: 1=

	demands' [p. 439, 28]	not at all true, 4 = exactly true).
Self-esteem	Rosenberg's Self-Esteem Scale (RSES) [29]	A *four-item version that correlates well with the original 10-item scale with* high internal consistency. *Higher mean scores (range 1–4) reflect higher self-esteem.*
Body Image	Body Areas Satisfaction Scale (BASS) [30]	Satisfaction with seven body areas is normally rated on a six-point scale, but in OBSS a five-point scale is used to compare with Norwegian studies using this response format (1 = very dissatisfied, 5 = very satisfied).
Emotion regulation	Emotion Regulation Questionnaire (ERQ) [31]	Six items measured reappraisal (e.g., 'When I want to feel less negative emotion, I change the way I'm thinking about the situation'), and four items measured suppression (e.g., 'I control my emotions by not expressing them'). Higher mean scores (range 1–7) indicate higher degrees of reappraisal/suppression.
Anxiety/Depressive symptoms	Hospital Anxiety and Depression Scale (HADS) [32]	The scores were summarized into separate scores on anxiety and depression. Higher scores (range 0–20) reflect a higher degree of symptoms.
Resilience	The Resilience Scale for Adults (RSA) [33]	A 33-item scale measuring protective factors important for preventing maladjustment and psychological problems with five subscales: personal competence, social competence, personal structure, family cohesion, and social support. Higher mean scores (range 1–5) indicate greater resilience.

Satisfaction with relationship	Relationship Assessment Scale (RAS) [34]	A five-item scale with response options from 1 (little) to 4 (much)

Figure 2. Rates of dietary adherence

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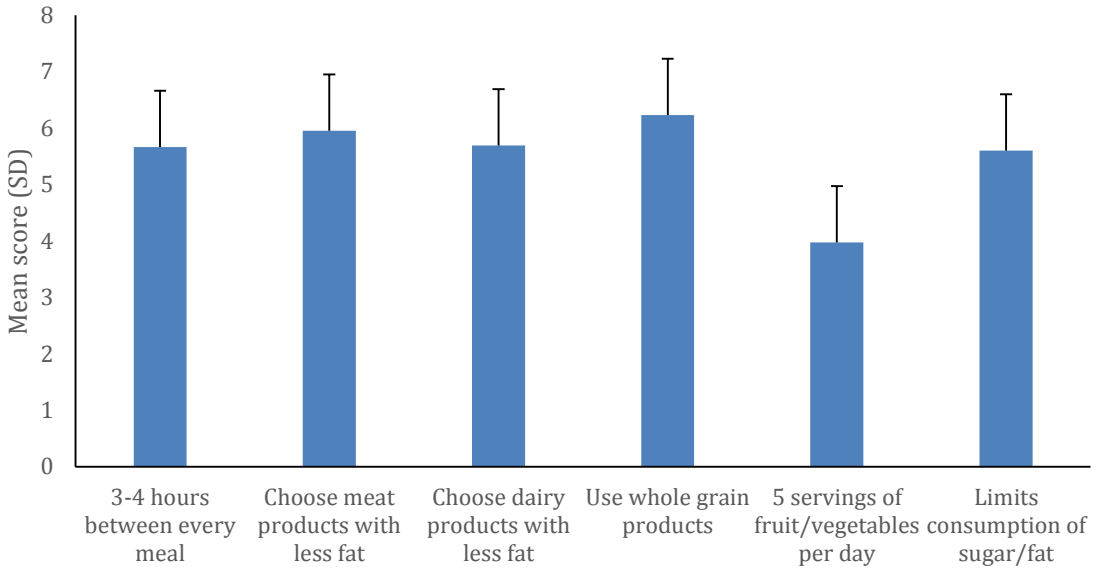

Table 2. Correlations between preoperative variables and adherence to dietary recommendations, physical activity and total weight loss (%) postoperatively (n = 230)

	Dietary Adherence	Physical activity	Weight loss (%)	Mean	SD	α
Age	.08	-.20**	-.26***	44.44	9.61	
Sex	-.11	-.01	-.14*	1.22	0.41	
BMI (kg/m^2)	.03	-.05	-.05	44.9	5.72	
Previous behavior - Weight loss/diet history						
Preoperative weight loss %	.06	.03	-.14*	3.87	5.71	
Years with dieting experience %	.24***	.05	.09	54.58	17.76	
Diet strategies used [a]	.03	.01	.16*	4.92	2.35	N/A
Number of times lost >10 kg	.13	.03	.03	4.26	3.35	
Magnitude of largest weight loss	.03	.15*	.22**	24.39	14.83	
Number of times participated in an organized diet program	.03	-.02	-.02	3.47	3.83	
Preoperative behavior						
Alcohol use	-.02	-.14*	.02	4.19	1.73	N/A
Frequency of snacking	-.08	-.09	.23**	2.93	0.51	.43[e]
Night eating tendency	-.25***	-.09	-.14*	1.17	0.50	N/A
PA (MET-min/week)	.10	.39***	.14*	1881	2322	
Binge eating	.01	-.09	.03	1.69	0.83	N/A
Psychological factors - Motivation/expectations						
Weight loss goal (%) [b]	.05	-.06	-.01	37.71	7.65	N/A
Well-being expectations	.05	.09	-.01	8.34	1.34	.84
Social competence expectations	-.05	.01	.02	7.28	1.74	.73
Readiness to limit food intake	.29***	-	-.05	9.04	1.13	N/A
Readiness to increase PA [c]	-	.25***	.05	8.43	1.60	N/A
Planning eating behavior	.08	-	-.02	3.01	0.53	.85
Planning physical activity	-	.34***	.00	2.72	0.59	.93
Self-efficacy	.09	.14*	.09	3.10	0.44	.87
Psychological factors - Self-evaluation/emotional distress /social factors						
Self-esteem	.15*	.15*	-.01	2.66	0.73	.82
Body Image	.15*	.16*	.01	2.44	0.55	.74
Emotion reg. - reappraisal	-.03	.05	.01	4.00	0.85	.80
Emotion reg. - suppression	-.08	.00	-.06	3.79	1.05	.78
Anxiety symptoms	-.10	.04	.03	7.04	4.29	.84
Depressive symptoms	-19**	-.14*	-.04	5.41	3.78	.78
Resilience	.18**	.09	-.04	3.64	0.64	.93
Satisfaction with relationship [d]	.09	.03	.04	5.52	1.15	.85

Note: [*]p < .05; [**] p < .01; [***] p < .001; α = Cronbach's alpha; N/A = Not Applicable; Sex: women = 1, men = 2; [a] less carbs, fat and sweets; [b] Difference between preoperative weight and weight loss goal (indicated 'happy weight' postoperatively); [c] PA = physical activity [d] n = 165, only those in a relationship answer this question; [e] Mean inter-item correlation reported.

Table 3. Results from three linear multiple regressions with adherence to dietary recommendations, physical activity

and % total weight loss as criterion

					95 % CI B coefficient		
	B	β	Part corr.	p-value	Lower	Upper	$R2_{adj}$
Dietary adherence (n =211)							
Years with dieting experience (%)	.01	.18	.18	.006	0.03	0.18	
Readiness to limit food intake	.20	.21	.20	.001	0.09	0.32	
Night eating tendency	-.45	-.22	-.21	.001	-0.71	-0.18	
Depressive symptoms	-.03	-.10	-.08	.195	-0.07	0.01	
Resilience	.07	.04	.04	.571	-0.18	0.33	$.17^{***}$
Physical activity (n =218)							
Readiness to increase PA	147.78	.08	.08	.21	-84.39	379.94	
Planning PA	1066.80	.22	.20	.001	435.93	1697.67	
Preoperative PA	.35	.29	.28	<.001	0.20	0.51	
Age	-35.29	-.12	-.12	.06	-71.32	0.75	$.22^{***}$
Weight loss % (n = 193)							
Magnitude of largest weight loss	.13	.24	.24	<.001	0.06	0.20	
Frequency of snacking	2.02	.22	.21	.001	0.79	3.25	
Age	-.22	-.25	-.25	<.001	-0.33	-0.10	$.16^{***}$

Note:

*** p < .001; $R2_{PRESS}$ dietary adherence = $.14^{***}$, $R2_{PRESS}$ PA = $.21^{***}$ and $R2_{PRESS}$ weight loss = $.15^{***}$.